Methane dry reforming using oil palm shell activated carbon supported cobalt catalyst: Multi-response optimization

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ABSTRACT

Dry reforming of methane with carbon dioxide was investigated using oil palm shell activated carbon (OPS-AC) supported cobalt catalyst. The cobalt loaded OPS-AC catalysts were prepared by wet-impregnation method and characterized using SEM, FESEM, BET, TPR and TPD. Surface morphology of OPS-AC supported cobalt catalysts exhibited higher porosity, surface area and micropore volume with different densities of cobalt particles and support. Furthermore, greater amount of H_2 chemisorbed and acidity were observed with increasing cobalt contents. Response surface methodology (RSM) was employed to design the experiments based on factorial central composite design. Catalytic testing was performed using a micro reactor system by varying four variables: temperature, gauge pressure, CH_4/ CO_2 ratio and gas hourly specific velocity (GHSV). H_2 and CO yields were analyzed and quantified by gas chromatography with thermal conductivity detector (TCD). Both responses (H_2 and CO) yields were optimized simultaneously using desirability function analysis. Reaction temperature was the most influential variable with high desirability prevalent for both responses. The optimum response values of H_2 and CO yields corresponded to 903 °C, 0.88 bar(g), CH_4/ CO_2 = 1.31 and GHSV = 4,488 mL/h.g-catalyst.

KEYWORDS

Oil palm shell; Activated carbon; Cobalt catalyst; Methane dry reforming; Multi-response optimization

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